Evaluation of Aeronautical Design Standard-33 Using a UH-60A Black Hawk

Christopher L. Blanken, David R. Arterburn, Luigi S. Cicolani

The U.S. Army's Aeronautical Design Standard–33 (ADS-33D-PRF) is a rotorcraft handling-qualities specification that was developed at Ames. Because this specification was initially applied in the RAH-66 Comanche helicopter program, the requirements generally related more to scout and attack rotorcraft. Recently, Ames expanded its handling-qualities research work to include utility rotorcraft, with and without externally slung loads. As part of this research, an 80-hour flight-test assessment of ADS-33D-PRF was conducted at Ames using an instrumented UH-60A Black Hawk, the Army's primary utility helicopter. The trial was performed (1) to assess the required compliance testing and to evaluate the requirements in a good visual environment; (2) to tailor the existing flight-test maneuvers and develop new maneuvers specifically designed to adequately evaluate the handling-qualities of utility helicopters, with and without externally slung loads; (3) to correlate the results from the quantitative testing with those from the qualitative evaluations; and (4) to establish a handling-qualities baseline of the UH-60A in terms of ADS-33 against which the effects of future modifications to the aircraft may be better quantified.

The 80-hour flight test was performed in three phases. Six pilots participated in Phase 1, the purpose of which was to tailor the existing ADS-33D-PRF flight-test maneuvers and to develop new ones. As shown in figure 1, course cueing for these flight-test maneuvers was constructed and refined to provide sufficient cues such that the evaluation pilots could determine "Desired" and "Adequate" maneuver performance standards. Eight experimental test pilots participated in the Phase 2 formal handling-qualities evaluations of the Black Hawk for these maneuvers and for three aircraft configurations: empty (approximate average weight = 13,500 pounds); with an internal ballast (17,300 pounds); and empty but with a 6,000-pound externally slung load (total operating weight 19,300 pounds). Data were collected in calm (<5 knots) and light wind conditions (7-15 knots). During Phase 3, the empty and internal ballast configurations were used to assess the compliance testing and criteria from the quantitative requirements in ADS-33D-PRF at hover and in forward flight.

Selected flight-test maneuvers from ADS-33D-PRF and from a CH-47D cargo helicopter assessment were refined for the utility mission. The maneuver performance standards were generally aligned with those developed in the cargo helicopter flight test. The addition of light winds (7-15 knots) tended to degrade the handling-qualities for some maneuvers more so than others. From the internal ballast configuration, the qualitative results for calm conditions (shown in figure 2) suggest that except for the Hover Turn and the Pirouette maneuvers, the average Handling Quality Rating (HQR) for the UH-60A, as tested, is close to the Level 1-2 boundary. The Phase 3 results showed that with real-time monitoring of the control inputs and aircraft response, the frequency-sweep testing and the steps, doublets, and pulse control inputs were performed in a routine and efficient manner. The initial lessons learned and results from this flight-test assessment of ADS-33D-PRF using a UH-60A Black Hawk helicopter will be instrumental in expanding the D-version of ADS-33 into an E-version that includes a first-cut at criteria suitable for utility rotorcraft, with and without externally slung loads.

Point of Contact: C. L. Blanken
(650) 604-5836
cblanken@mail.arc.nasa.gov

Fig. 1. UH-60A Black Hawk with externally slung load performing maneuver assessment.